Circularly Polarized U Slot Microstrip Patch Antenna

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Abstract— **A novel miniaturized circularly polarized microstrip patch antenna with improved characteristics operating at 2.3 GHz using IE3D software is proposed. An asymmetrical U-slot is discussed to generate the two orthogonal modes for circular polarization without cutting a sloping edge to any corner of the probe fed square patch antenna. Circular polarization reduces the loss caused by the misalignment between the signal and the receiving antenna. The center frequency of the designed antenna is widely applied to applications such as satellite communication systems like MSAT and GPS. A parametric study has been carried out to investigate the effects caused by different arm lengths of U-slot, width of slot, height of slot and gap between the arms of U-slot.**

Keywords-**Circular polarization, U-slot, IE3D**

I. INTRODUCTION

The radiation of antenna is defined by three parameters: axial ratio, tilt angle and sense of rotation. When the axial ratio is infinite or zero, the polarization becomes linear with the tilt angle defining the orientation. The quality of linear polarization is indicated by the level of the cross polarization [1]. When the axial ratio is unity, a perfect circular polarization results and the tilt angle is not applicable. The axial ratio is used to specify the quality of circularly polarized waves. Antennas produce circularly polarized waves when two orthogonal field components with equal amplitude but in phase quadrature are radiated [2]. Two types of feeding schemes among which a dual orthogonal feed, which employs an external power divider network, is discussed [3]. A single point feed for which an external power divider is not required is also discussed [4]. Dual circular polarization has also been achieve d using a singly fed triangular or pentagonal micro strip antenna [5,7]. A triangular patch radiates circularly polarization at dual frequencies, f1 and f2, with the separation ratio depending on the aspect ratio b/a [6]. The previous work discussed achieves circular polarization but the compact size and center frequency of 2.3GHz can be achieved by a novel design with asymmetric U- slot.

II. DESIGN OF THE PROPOSED ANTENNA

A. Antenna Design

A ground plane and a square patch on itare designed as per the dimensions in table1.

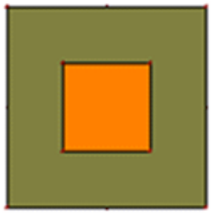

Figure1: Patch Design On Ground Plane

Table1: Parameters Of Ground Plane And Patch

Parameter	Dimension(mm)
Length of ground plane (Lgd)	102
Width of ground plane(Wgd)	102
Length of patch	44.7
Width of patch	44.7
Thickness of substrate	3

B. Novel Design

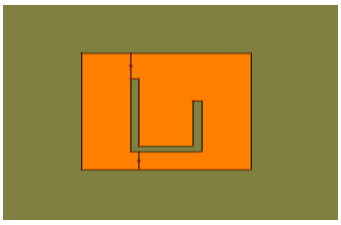

Figure2: Antenna With U-Slot

One of the arms of U slot is shortened to achieve desired circular polarization as shown in figure2. The proposed U slot can generate two orthogonal modes for circularly polarized radiation. Therefore no extra stabs or chamfering at the corners of square patch is necessary as shown in figure1. The U slot is located on the microstrip square patch which sits on top of a piece of 11mm thick foam

substrate. By adjusting the length of arm of U slot (either Lul or Lur) to optimum position in y-direction, good circular polarization can be achieved. The left arm of the U slot is longer than the right arm so the antenna is left hand circularly polarized. Right hand circular polarization can be achieved if right arm is shorter than left arm. But it is observed that if the length of right arm is decreased then the directivity of antenna is being reduced. The optimum dimensions of the design are obtained as shown below.

Table2: Optimum Dimensions Of The Antenna

PARAMETER	DIMENSION (millimetre)
Length of ground plane (Lgd)	102
Width of ground plane (Wgd)	102
Length of patch (Lp)	44.7
Width of patch (Wp)	44.7
Thickness of substrate (h)	11
Length of left arm (Lul)	26.85
Length of right arm (Lur)	24.3
Gap between two arms of U- lot (Wu)	16.9
Height of U-slot (Lub)	8.6
Width of U-slot(Ws)	2.3

The various parameters of the patch antenna are varied and simulated for different dimensions and finally the optimum dimensions are obtained as shown in table2.

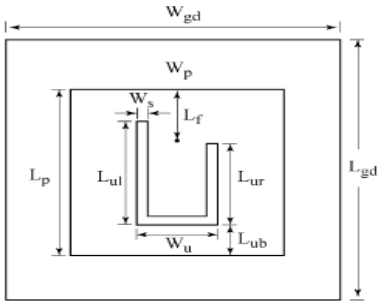

Figure3:Circularly Polarized U Slot Antenna

III. RESULTS OF THE PROPOSED ANTENNA

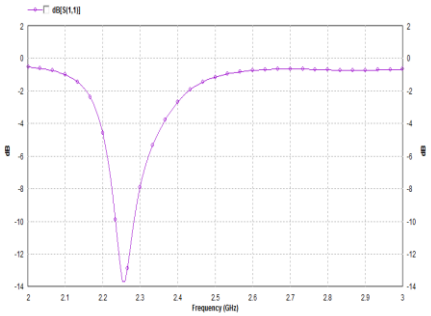

Figure4: Return Loss (S11)

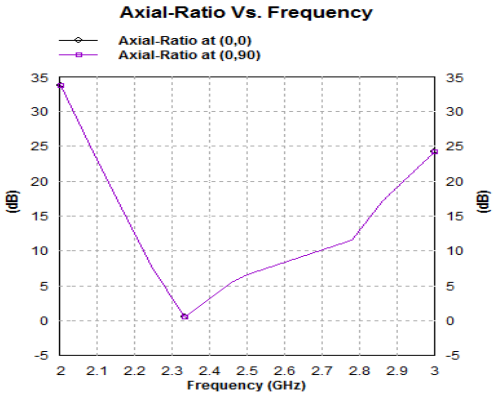

Figure5: Axial Ratio

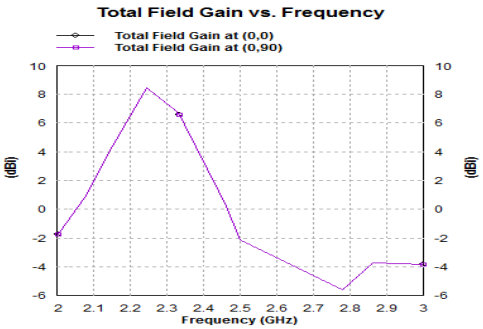

Figure6: Gain Characteristics

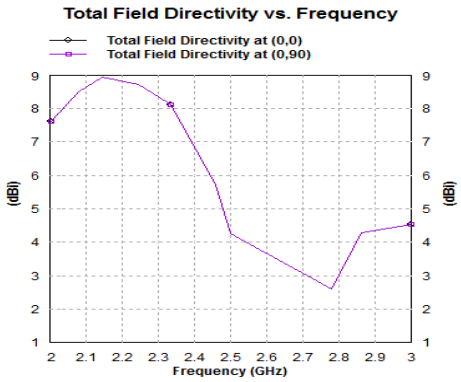

Figure7: Directivity Of The Antenna

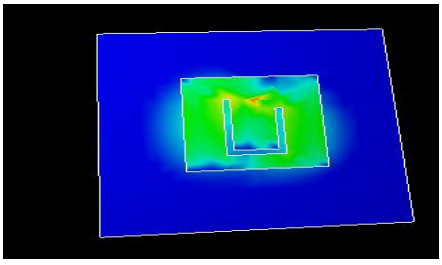

Figure 8: Surface Current Distribution

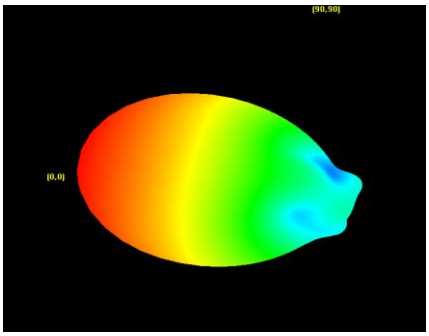

Figure 9: Radiation Pattern

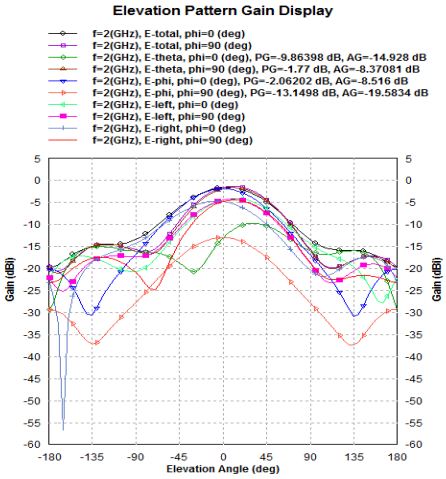

Figure 10: Elevation Pattern

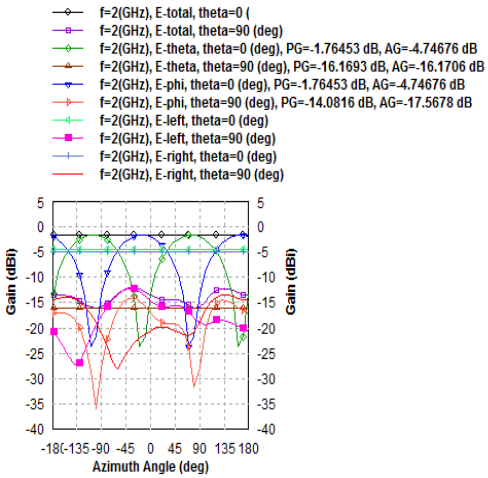

Figure 11: Azimuthal Angle

IV. CONCLUSION

The design of circularly polarized U-slot antenna using IE3D software has been discussed. Various parameters of the antenna have been varied and simulated. It has been observed that if height of the right arm (Lur) is decreased then better axial ratio is obtained and by increasing the height of slot position better return loss is obtained. But if the substrate thickness is increased or decreased it has negative effects on return loss. Similarly if the gap between the two arms of U-slot is increased or decreased then it has negative effect on axial ratio so it is maintained at a constant value of 16.9mm. The asymmetrical arms are responsible to make the antenna circularly polarized. The arms lengths have been varied for different values and found that if the ratio between these lengths is 0.9 then an antenna with desired circular polarization can be obtained. The axial ratio for these lengths has been observed as 0.5 dB. Also the length of right arm is decreased significantly because if the length of left arm is decreased then directivity of antenna is being reduced. The return loss for the designed antenna is observed as 14.8 dB. The gain of antenna has been observed as 8.28 dBi.

V. ACKNOWLEDGMENT

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VI. REFERENCES

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